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A Microeconomic Approach of the Dynamics of Creation¹.

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Abstract.

The aim of this contribution is to analyse the *period of research* that goes from the emergence of the first innovative idea to the moment when a patent can be written and claimed for. We argue that the period of research is characterised by the building of public or semi-public good in order to equip the innovative idea with a “codebook” (shared codes, tests, and “grammar of usage”) and reveal its economic potential. We emphasize in this period of research the role of knowing communities as the active units of the dynamic process of invention. We then discuss some consequences in two domains of application: property rights and creative clusters.

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1. Introduction

There is growing evidence that the process of invention is generally a collective effort that necessitates the interaction and coordination of a multitude of economic actors. Increasingly, the literature on the role of cooperative agreements in R&D emphasises that the *period of research* that goes from the emergence of the first innovative idea to the moment when a patent can be written and claimed for, is in fact rarely assimilable to a *patent race* of isolated inventors. This period of research is rather characterised by the building of R&D consortia, by the formation of pools of inventors, or by collective ventures in local clusters specialised in high tech. The inventive idea needs to come equipped with shared codes, tests, and “grammar of usage” before being considered as having an economic potential. Without the building of this public or semi-public “codebook”, most of the inventive ideas are not economically viable.

As an example, Cassier and Foray (2002) underlined the role of R&D consortia, as an important tool and institutional mechanism allowing the collective creation of knowledge. As they note, a R&D consortium offers the following characteristics:

- “It creates spaces for sharing knowledge, in which there is a break from technological secrecy and the retention of knowledge by private agents. It generates a new economic category of knowledge called collective or pooled knowledge, which is shared among participants during the period of research.

- It allows agents to develop concerted actions by organizing the division of labour to explore a certain domain and providing an institutional framework to assemble divided and dispersed knowledge.

- It can enable agents to create a more consistent and coherent initial endowment of intellectual property rights, which does not fragment the knowledge base. When the knowledge is initially fragmented (anticommons property), the consortium provides a space in which rights can be exchanged at a low cost, because partners are well identified and some collective learning can occur”. (Cassier, Foray, 2002: 124)

Thus, what these studies and observations suggest is that the *period of research* is often characterised by stronger economic motives to pool and share knowledge than to delineate private domains of knowledge and keep secrecy. However, if it is widely and increasingly acknowledged that invention has a collective dimension, the dominant economic approach of invention is still focused on the representation of a solitary inventor as set forth in the seminal contribution of Arrow (1962) dealing with knowledge creation in the firm, and by the image of the opportunistic *patent race* of isolated investors that logically derives from it.

The aim of Arrow’s approach, that we call here the “traditional approach”, was to highlight the issue of imperfect appropriability and the associated trade off between incentives to innovate and diffusion. To do so, Arrow introduces a very strong hypothesis: the development of innovation is reduced to a two step static process. The first step is the phase of invention, the second step is the phase of a generalised diffusion. The dynamics of creation and the pace of evolution of innovation are « crushed » in the

representation of the static process. The phase of invention is initiated and achieved by a solitary inventor facing the opportunistic behaviours of the other agents. The new knowledge produced by the solitary inventor is assimilable to information which possesses the generic properties of a pure “public good” (non-rivalry and non-exclusion). In such a context, the production of new knowledge faces the key problem of appropriability: it is difficult for the inventor to appropriate the benefits which flow from it. At the level of society, the trade-off between incentives to invent and diffusion of innovation is raised, and the main solution for solving this issue is to build a strong system of property rights. Thanks to these mechanisms, the second phase of the process, the (controlled) phase of generalised diffusion can start.

The aim of this contribution is to depart from this traditional representation by “opening the black box of the phase of invention” and analysing the complex microeconomics phenomena that take place during the period of research, and which favour a collective approach to the process of creation. Our objective is to grasp the processes and procedures through which communities are formed, collective goods produced and the social benefits of the activity enhanced. In the first part, we present a model of collective production of knowledge during the period of research which is based on recent results from sociology of innovation. This model revisits Arrow’s contribution and leads to the conclusion that the traditional vision of weak appropriability in the process of development of new technologies is only valid for an extreme phase of the period, when the characteristics of the technology are clearly and universally understood. In the second part of the article, we derive the main consequences from this model in two domains: first we suggest an interpretation in the domain of practical regimes of appropriability, and second we suggest some application of this approach in the domain of creative clusters.

2. A model of collective invention.

In the phase of emergence of invention, most of the empirical works and historical analyses have shown that what matters is the progressive building of collective knowledge and understanding between actors. At this stage, there is neither a common language nor a common representation between the different players. The group of agents who succeed in expressing and formalizing an innovative idea is confronted by a main difficulty: not the risk of being copied (at no cost), but the risk of being misunderstood by others (including agents belonging to the same institution). It is therefore the risk that their procedures and experience will not be reproduced by others. Without a collective effort to reach a critical mass of common understanding between the different actors committed in this emerging phase, the innovation process can not be viable. The group of agents at the origin of an innovation must undertake considerable efforts to alert other actors or communities in order to convince them of the usefulness and potentials of their discovery. These features of the emerging phase of the process of development of innovation are not captured by Arrow’s vision. In Arrow’s perspective, the producer of knowledge acts in isolation: nothing is said about the complementary forms of knowledge necessary for the producer of knowledge to invent, and nothing is said about the community of agents who supported him in the process that lead to the invention.

2.1. Revisiting the traditional Arrovian hypotheses.

To be more precise, as Callon (1999) emphasised, in the phase of emergence of innovation, the production of knowledge tends to exhibit exactly the reverse properties than the one postulated by the traditional approach: knowledge is essentially rival (it is extremely difficult to reproduce the new knowledge in a place that is not the place where the invention has been first realised) and exclusive (the novelty relies heavily on the tacit knowledge of inventors). In this context of emergence, knowledge is also essentially specific (it can be absorbed and used by a few other agents only) which is the opposite of the traditional vision that postulates that knowledge has a high degree of generality (knowledge with a high degree of generality can be potentially used in various contexts by a large variety of agents: all the agents of the economy have the full capability to absorb the innovative idea emitted by the producer of knowledge).

The logical conclusion therefore is that in the phase of emergence, there are important reasons to support a hypothesis of strong appropriability. It is not the issue of appropriability that matters the most during this phase, but the issue of the building of a quasi-public good: the critical mass of understanding between inventors or more precisely communities of inventors, from which codes and grammar of usage of the novelty will progressively be developed, in order to reproduce, extend, and make the initial creative ideas viable. It must be added that in this emerging phase of production of knowledge what the observations and empirical works show is that the active units of building of a cognitive platform at this stage is generally not the individuals, nor the institutions, but the *knowing communities* of agents that are committed to the creation and accumulation of the new forms of knowledge. As we will see later, individuals and institutions also play an important role in the microeconomics of collective creation, but the fundamental cognitive building of the codes and grammar that will equip the novelty requires the active functioning and interactions of knowing communities.

2.2. The key role of knowing communities

A *knowing community* (Boland and Tenkasi, 1995) can be defined as a gathering of individuals who accept to exchange voluntarily and on a regular basis about a common interest or objective in a given specialized field of knowledge. Through this regular exchange, common cognitive platforms and common social norms are built that assure the cohesion of the community and guide the newcomers' behavior. Knowing communities can deal with knowledge in different ways: some may focus on the accumulation and exploitation of a given field of knowledge (communities of practice, Lave and Wenger 1990), others may focus on the exploration of a new field of knowledge (epistemic communities, Cowan et al. 2000). The focus given in this contribution on the *period of research* seems to naturally highlight the role of epistemic communities that are the base of the academic milieu and whose task is directly targeted on the production of new knowledge⁵. However, it could be misleading to solely focus on these epistemic communities. The building of a "grammar of usage" to equip the

⁵ *Epistemic communities*: are small groups of "knowledge-creating agents who are engaged on a mutually recognized subset of questions, and who (at the very least) accept some commonly understood procedural authority as essential to the success of their collective activities." (Cowan et al., 2000, p. 234).

inventive idea also requires the interaction with communities rooted in the daily practice such as communities of practice, that might be found in traditional work divisions and departments, or that might also cut across functional divisions, spill over into after-work or project-based teams, and straddle networks of cross-corporate and professional ties.

A growing literature underlines the increasing role of knowing communities in society. As the knowledge-based economy expands, knowing communities are playing an increasing role, because they can take charge of some significant parts of the *sunk costs* associated with the process of generation or accumulation of specialized parcels of knowledge. These costs correspond for instance to the progressive construction of languages and models of action and interpretation that are required for the implementation of new knowledge, that cannot be covered through the classical signals of hierarchies (or markets). This setting is likely to compensate for some organizational limitations (learning failures) that firms are facing when confronted with the need to continuously innovate and produce new knowledge.

2.3. The process of collective invention viewed as a codification process.

The role of knowing communities in the *period of research* process is essential: they achieve a process of progressive codification of knowledge, starting from a phase where the actors do not know the characteristics of the novelty, do not know each other, and do not possess the capabilities to communicate in order to reach a phase where the novelty is equipped with sufficient shared understanding and codes to become economically viable. Thus, the development of invention requires the progressive building of a common base of knowledge, a model and a “grammar” to be able to interpret tests, experiences and contexts of usage.

In such a perspective, the above discussion suggests that an essential part of the process of production of knowledge can be interpreted as resulting from the dynamics of interactions between knowing communities. These interactions can be approached through the principle of ‘translation/enrolment’ elaborated in particular by Callon and Latour (1991). Interpreting these authors, the innovative diffusion of ideas (for example from the lab to the market) can be seen as a process of progressive contagion of communities, where each community makes efforts to ‘command the attention’ of other communities to convince them of the relevant interest of the knowledge it has elaborated.

This essential process of progressive codification that lies behind the scene of the development of innovation is not a linear one. It generally involves an early phase during which the innovators encounter misunderstandings, and difficulty to convince. The first steps in the emerging phase can be long and painful. It generally requires the intense involvement of specific individuals, acting as boundary spanners, to facilitate the dialogue between knowing communities.

2.4. The key role of boundary spanners

It is at this stage that the role of key individuals may be a determining factor. Two communities may interact directly through random meetings of members of both groups, and this interaction certainly could be favoured by some mechanisms such as the

repetitiveness of interactions between communities or by a high degree of quality of communication between communities⁶. However, though these conditions may contribute to lower the cognitive distance between communities, they do not guarantee in the long term the spontaneous building of a common grammar and codes between heterogeneous units. For this reason, the role of specific individuals playing the role of “boundary spanners” (Allen, 1977; Tushman, 1977; Cohen and Levinthal, 1990), is of key importance. Those individuals are generally members of a given community who have progressively acquired a reputation (frequently they are the “stars” of the community) and who have the ability and authority to express and translate the concern of their community into the language and representation of other communities. As an example, Girvan and Newman (2000) have illustrated the property of community structure in a scientific network, where people are working together in tightly-knit groups between which there are only looser connections. They show the role of boundary spanners played by the leading members of each community, who assure the circulation and building of common knowledge between communities.

Once this progressive process of building of common knowledge has started, then by a progressive contagion of communities the building of a common base of knowledge can accelerate through different tests and the elaboration of diverse codes. These micro-additions to the common base then cumulate and speed up to reach a level of *percolation*

⁶ The *repetitiveness of interactions* between communities expresses the “quantitative” dimension of the relationships between communities. Some communities may meet frequently (e.g. workers and managers using the same canteen), and this can generate some benefits for the firm (e.g. formation of a certain common knowledge, circulation of news that ‘something isn’t going well’), even though the intensity of communication between them is low (e.g. minimal common language or grammar to improve the circulation of knowledge between the communities). A high degree of repetition of interactions between knowing communities contributes to stimulate the processes of learning, create favorable conditions for the resolution of conflicts, and encourage the realization of economies of scale. Organizational devices, such as group projects or frequent meetings encouraging the socialization of experiences, are regularly introduced by the management to compensate for the lack of spontaneous interaction between heterogeneous communities. This enables us to better understand the importance given to the construction of privileged learning platforms by firms (‘ba’ in the sense of Nonaka and Konno, 1998).

The *quality of communication* between communities expresses the “qualitative” dimension of the relationships between communities. Some communities can be joined together through a rich texture of communication, even if the quantitative ‘degree of repetition’ of interaction is low. Minzberg (1979), for example, quotes the well known example of operations in hospitals, where the members of the different communities involved (surgeons, anesthesiologists, nurses) meet infrequently but when they do so, they know exactly what to do and how to work together (thanks to the possibility of communication provided during their respective training). Circulation of knowledge in an innovating firm is based essentially on the sharing of codes and languages allowing various communities to interact. Thus, it is a question of relational or *cognitive proximity* (Nooteboom, 2000) between distributed units, requiring attention to syntactic, semantic and pragmatic communication, shared tacit knowledge, flow and interpretation of information, and trust or other conventions of collaboration.

in the system (Willinger and Zuscovitch, 1988), which corresponds to a situation where the novelty is fully equipped with a code and grammar leading to a potential economically viable application.

2.5. The stabilized phase of the process: meeting the traditional conditions

It is only at the end of the process, at a stage which can be described as the “*phase of stabilisation*”, when the characteristics of the novelty are fully understood, and described in codes and procedures that every agent can access and use, that we reach a situation which corresponds to the traditional context of production of knowledge as described by Arrow. The stabilised phase is reached when this codification process is over. At this stage only, the different actors that intervened in the process have achieved the building of a quasi public good, the common knowledge base of the novelty, which relies on common codes, norms, and principles. The market opportunities are predictable, the languages are stabilised, the laboratory procedures and tests can be replicated. In such a context, knowledge can be treated as “information” and possesses the two generic properties of a pure “public good”. Only in this situation, imitators fully equipped with perfect absorptive capabilities can “take the innovative ideas and run” without compensation for the producers of the novelty. Only in this situation, the hypothesis of weak appropriability is valid and should lead to the application of the classical policy. From this quasi public platform, imitation can easily take place, and Arrow’s vision can apply. In a way, the public good character of innovation at this stabilised phase is the result of the cognitive construction of innovating communities throughout their interactive process (a table summarising the differences between the traditional Arrowian vision of the production of knowledge and the collective vision that has been exposed in the above discussion is provided in Annex I).

2.6. The respective roles of institutions, individuals and communities.

What the above model suggests is that the process of invention is far from being restricted to the sole role of talented individuals, or far from being controlled by the strategic vision of institutions (firms and labs). Institutions are instances where contracts are signed, where people are hired or fired, where broad competences are managed. They are not the active units of elaboration of this common base indispensable for the development of innovation. The active units which undertake the codification process are in our view the diverse knowing communities that participate in the process of invention, (as well as the small set of active individuals who play the role of boundary spanners between communities). These communities are essential in the phase of emergence of novelty, then their role diminishes (and the role of institutions increases) as the knowledge base grows and is reinforced. When the process is stabilised, the dominant players become the institutions. The story of the production of new knowledge, at least in this *period of research*, could thus be interpreted as a process where individuals, institutions and knowing communities interact, each contributing through its activities of knowledge to mitigate the limits and possibilities of failure of the others. There could be different spatial contexts where this story takes place: it could be within a given firm, in a purely academic milieu, in a cluster linking scientists and industrialists, or in virtual

space. Whatever the spatial context the same types of actors will be present (in the next part, we will explore in more details the case of creative clusters).

2.7. The process of innovation beyond the phase of emergence.

Once the codebook that equipped the creative idea is fully achieved, a new phase of the innovative process can take place: the phase that will bring the invention to commercialisation and beyond, to diffusion. In the phase of emergence, the production of *externalities* was negligible. The core elements of the phenomena are processes of conviction, translation and enrolment from one community to another community which contribute to internalise the externalities. The externalities were internalised through the process of controlled communications that lies behind the building of a common base of knowledge to make the innovation understandable and viable. In the new phase of diffusion, the question of externalities does matter. Our view is that the intense work of codification that has taken place in the preceding *period of research* largely determines and shapes the nature of the next phase of the innovative process. Will the novelty lead to a patent application? If yes, who will obtain the patent or who shares the property rights? How will the licences, if any, be distributed? What types of markets are targeted? These are all questions that have already been tackled and answered in the previous phase. As Cassier and Foray (2002) underlined “collective invention produces a new boundary, an original partition between a set of co-ordinated agents and the rest of the world. The question of dissemination of results and thus of the social returns to collective research...raises the question of the composition of the group (those agents who have participated to the period of research), that is, the internalisation of knowledge externalities. Is the group composed of all the members of a set (an industry, for example)? – in which case the question of dissemination is less relevant. Or does it consist of a significant part of this set? – in which case collective invention may become an obstacle to the entry of new actors into the industry. Or lastly is it limited to a very small number? – in which case, the question of dissemination beyond the circle is raised.”

3. Some main consequences of the model of collective invention.

These results raise numerous issues. Among these, we have selected the following two: First, the consequences on the interpretation of property rights, in particular patents; second, the consequences on the interpretation of creative clusters.

3.1. The consequences in terms of the interpretation of property rights.

As Zuscovitch pointed out repeatedly (1998, in particular), there are theoretical and practical evidences that support the hypothesis that there is a rather strong appropriability in the processes of development of new technologies. This spontaneously stronger appropriability, based on the need of a collaborative dimension for the building of a common knowledge base, accelerates the rate of technological progress as a whole. What we have suggested in the previous part of this article is that the hypothesis of strong appropriability is particularly valid at the beginning of *the research period*. This

important fact has been recognized by Winter (1993), who while acknowledging that the patent system can increase incentives to innovate, suggests that intellectual property rights do not lead automatically to a more successful resource allocation. In particular, he underlines the fact that inefficiencies might especially occur during the very first phases of the creation of a technology trajectory. When a pool of innovators explores a new technology trajectory, the availability of older patents, he said, might block the slow build-up of a common base of knowledge required for the creation of such a trajectory.

This vision of strong appropriability seems to be contradicted by the increasing demand on property rights, which is addressed in all sectors and all countries. Our view (Cohendet, Farcot, Pénin, 2006) is that there is no contradiction, when considering the *diversity* of motives for firms to hold a patent. Among the motives, and besides the right to exclude, patents are also fundamental instruments of *signalling* allowing the producers of a piece of knowledge to have their competencies to innovate recognised by others. In that case, patents play a fundamental role of *coordination* of innovative activities. As a label of recognition of competencies, patents offer possibilities to be accepted in innovative networks or certificates of guarantee for firms to receive seed money from banks or specialised institutions. Moreover, we argue that the signalling motive is in general the highest motive in the phase of emergence of innovation, when the actors do not know each other. As the process of innovation matures and tends to reach the phase of stability, the signalling motive relatively weakens, while the exclusion motive increases. To a large extent the *period of research* could be seen as the one leading a creative idea from a stage where it relies on purely appropriable knowledge with a minimal economic potential to a stage where it is patentable with a strong economic potential.

The vision of strong appropriability seems also to be contradicted by the current practice in some specific sectors such as the pharmaceutical one, where the demand for patents as a means of exclusion is prevalent, even in the earliest phases of the process of innovation. According to us, this fact is explained by the sector context-dependent characteristics of the use of property rights. These sectors are the exception rather than the rule. In a few sectors, the nature of novelty relies essentially on codified statements, even in the earliest phases of the process of innovation. A new drug relies on a small number of molecules that can be easily reproduced if one “steals the formula”. In this industry, the context of production of knowledge is such that the exclusion is of prime importance. This is in line with Zuscovitch’s conception of technological innovation (1998) which takes place within a particular structure, a specific context of industrial products and production processes that occurs differently across industries and over time. Figure 1 illustrates how the two main dimensions of the nature of invention, the codified/tacit dimension, and the emerging/stabilised phase, leads to four main contexts of modes of usage of patents.

- Firstly, the fundamental distinction between tacit and codified knowledge clearly suggests that the tacit context in which knowledge is created has an influence on appropriation conditions and on the ability of patents to increase incentives. For example, in those domains where codified aspects of knowledge seem to be prevalent (chemicals, pharmaceuticals), where the

extent of what can be patented is clearly established, understood and accepted by all concerned actors, then the role of patents as an instrument to increase incentives is strong. On the contrary, in contexts where the tacit dimension seems to prevail (such as software or services for example), the incentive role of patents tends to be weakened.

- Secondly, knowledge-based economics provides a new role for patents, in response to the important needs of coordination of the actors in the first stages of the innovation creation process. In the emerging phases of a new innovation, the need to build a common knowledge base is strong and therefore strategies of collaborations tend to overcome strategies of exclusion. As soon as innovations become more mature and situations are stabilised, languages are shared, the importance of patents as an instrument of exclusion increases. It comes out of this analysis that the role of patents is highly dependent on context, sectors and their specific evolution. In mature sectors where the technology is tested and coordination already ensured, actors will tend to favour a traditional patent strategy, while in emerging sectors, the construction of strong intellectual property rights based mostly on exclusion may induce devastating effects.

Crossing those two dimensions allows defining very different industrial contexts, in which the role of patents differs strongly.

Figure 1: The context-dependent modes of usage of patents (From Cohendet, Farcot, Pénin, 2006)

	Knowledge essentially codified	Knowledge essentially tacit
Emergent phase	Strong exclusion Strong coordination	Weak exclusion Strong coordination
Stabilised phase	Strong exclusion Weak coordination	Weak exclusion Weak coordination

3.2. The consequences in terms of creative clusters.

Within the context of collective creation, the concept of creative clusters has received a growing interest in recent literature (Saxenian, 1994; Andersen and Teubal, 1999; Bathelt et al. 2002; Bresnahan et al. 2002, Rullani, 2001; etc.). Creative clusters are generally viewed as small geographic locations centred on a particular industry which facilitates close face-to-face communications between the participants of the clusters. A creative cluster can thus be interpreted as a localised network that uses the territory to provide the dissemination of creative ideas (Rullani, 2001). The literature on creative clusters has extensively examined the conditions of success of clusters: among the main determinants of success, the existence of large pillar firms (Bathelt et al, 2002), of key agents (Saxenian, 1994), of small worlds (Uzzi and Spiro, 2005), of regional specialisation (Bathelt et al, 2002), of local “buzz” (Storper and Venables, 2004) have received specific attention.

From the perspective of the model described in the previous part, we suggest another key feature of creative clusters. In a creative cluster, knowing communities, active individuals and institutions are permanently interacting. This continuous interaction facilitates the emergence, not only of creative ideas, but also and chiefly of the conditions for the periods of research that follow the emission of a creative idea to be achieved successfully. Creative clusters can be seen as geographical contexts that favour the development of fertile *periods of research*, where the complex codification processes that are needed to equip the inventive ideas can take place thanks to the multitude of interactions between heterogeneous (communities, individuals, institutions) localised types of economic entities.

More precisely, the success of a creative cluster not only relies on the existence of active communities, active talent, and large firms, but on the capacity of communities to communicate and to build common platforms of knowledge, as well as on the presence of boundary spanners recognized as leading members of their community and who are able to express and translate the concern of their community into messages understandable by other communities, or of “entrepreneurs” who have the talent to integrate the perspectives and representations of diverse knowing communities. The success of a creative cluster also requires the existence of firms patient enough not to accelerate the process of protecting the inventive ideas and convinced of the virtues and economic interest of the collective cognitive building in the period of research.

What creative clusters offer are unique places for boundary spanners to meet face to face, for members of a given community to frequently meet members of other communities, for firms to have an immediate access to inventive ideas emitted by researchers, for immediate replication of experience made in a given lab, etc. Thus it is not so much the capacity to transmit tacit knowledge within a given geographical space that matters. It is much more the capacity of the geographical milieu to efficiently support the period of research and the associated codification process that are determinant in the successes of the process of innovation (Fleming et al. 2004).

As an example of a successful interaction between communities, institutions and individuals, we can reinterpret Saxenian's vision of Silicon Valley (1995). Here, interacting communities (of engineers, software designers, specialist firms, and so on) are genuinely self-organizing, in such a way that organization emerges from the interactions rather than the reverse. The management of the cluster is largely autopoietic, and dependent upon the structure of interaction and communication; thus, for example, if a firm goes bankrupt, the collective interaction of communities takes charge, to ensure that new organizations are formed and that the competences and experience of individuals are redistributed. Redundancy is maintained and sunk costs are not lost as a result of a systemic vibrancy that emanates from strong local ties. However, the role of specific individuals through their unique ability to bridge together heterogeneous communities must also be emphasised. In the case of Silicon Valley the key role was played by Frederick Terman (Cariou, 2006). Though a talented scientist, his contribution to Silicon Valley was not through the emission of any invention. "As a social and institutional innovator, Frederick Terman helped to shape the relationships among individuals, firms and institutions in Silicon Valley, creating a community that has encouraged continuous experimentation and technological advance for more than half a century" (Saxenian, 1995).

4. Conclusion

The approach suggested in this contribution emphasises the role and the need of collective endeavours in the period of research of any inventive process. Any creative idea needs to be equipped by a quasi public codebook to reveal its economic properties and potential. This approach focuses on the period of active negotiations and economic decisions that precedes the classical Arrovian phase of invention when a patent can be written and claimed for.

The discussion presented in the paper let open numerous issues. Among these issues, we like to underline two issues that deserve a specific attention:

The first one is the need to analyse in more details the behaviour of the actors of the process of invention that face the tension between on the one side the need to participate to the collective building of the codebook that should equip a creative idea, and on the other side the willingness to "hit and run" at the first favourable occasion. To a large extent the result of this tension depends on the context in which the inventive idea is developed, on the degree of trust between participating actors, and on the degree of competition in the related industry. In the case of the international breast cancer, for instance, Cassier and Gaudillière (1998) have shown that participants have effectively shared resources and data to narrow down the gene field (enabling them to target their own work better so as to remain in the race, and excluding groups not participating in the consortium). But the field of breast cancer genetics was so competitive that once the area to investigate has been defined, strategic knowledge was kept secret while each group negotiated with industrial firms and a patent race started within the consortium itself. The building of the quasi-public good in that case was limited to the writing of a

“geographical map” in order to delineate the area of investigation. The analogy with mineral prospection or deep-sea fishing is obvious: with the sharing of “geographic” information between a few agents, a first selection can be made among the groups, before the real competition can start.

The tension between participating to the common building of knowledge and shortening the process for private motives also depends on the subtle relationships between communities, individuals and institutions. In many instances, knowing communities are motivated to continue the process of collective building of the codebook, while institutions put pressures to shorten the process and accelerate the definition of the perimeter of property rights for the creative invention. As an example, under the Bayh-Dole Act regime in US universities, some epistemic communities may be tempted to continue the circulation and building of common knowledge in an open mode while the university to whom they belong put pressure to accelerate the claiming for a specific patent. There are many associated risks to a too drastic shortening of the *period of research*: The risk of an insufficiently developed codebook that will not allow the creative idea to expand and find useful application, or the risk of a patent race between participants that will result in an excess of research, etc.

The second issue that deserves a specific attention is the consequence in terms of public policy. To a large extent, the decision to build and reinforce the common base of knowledge of a given creative idea is mainly produced by local decentralised arrangements between participants. However, as already underlined, the process is context dependent, which let open large avenues of public intervention to facilitate and develop such contexts, in particular in the building and reinforcement of local creative clusters. In a different perspective the public involvement in some research consortia could also contribute to accelerate the economic potential of invention. Bach et al. (1995) found that firms associated with public centers of research in innovative consortia generate more indirect effects (“spin-offs”) and are more effective at achieving the objective of the research project. They underlined that the influential role played by the public partners in these consortia are due to the ability of the public units to take in charge the codification and standardisation of the collective knowledge within the consortia, while the private partners were less akin to do it. The result is a global enhancement of the collective process of research, due to the ability of writing common codebooks that equip the inventive ideas that emerged within the consortia.

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ANNEX I: Questioning the traditional vision of the production of knowledge (from Cohendet and Mayer Krahrmer, 2001)

<u>Arrow's (1962) hypothesis on knowledge production (the information perspective)</u>	<u>Questioning the Arrow's hypothesis in a knowledge-based perspective.</u>
<ol style="list-style-type: none"> 1. Knowledge treated as "information" possesses the two generic properties of a pure "public good". It is a <i>non-rival good</i> (infinitely expansible without being diminished in quality, so that it can be possessed and used jointly by as many as care to do so). It is a <i>non-exclusive</i> good (impossible or very costly to exclude individuals from benefiting from the good). 2. The only incentive that matters for the producer of knowledge is to experience the full ownership of the new piece of knowledge produced. There is no trade-off between the incentive to be the sole owner of the innovation and other forms of incentive that could influence the behaviour of the producer of new knowledge. 3. The producer of new knowledge is a <i>solitary</i> one. In Arrow's perspective, the producer of knowledge acts in isolation. Nothing is said about the complementary forms of knowledge that have been necessary for him to invent. Nothing is said about the community of agents who supported him in the process that lead to the invention. Nothing is said about the interest to him of the new piece of knowledge that has been produced (Is it an incremental invention aiming at improving a current process. Is it a radically new invention opening the perspective of new fields of research?). In such a solitary perspective, an important consequence is that the producer of knowledge is in a position to claim the totality of the invention. 4. The producer of new knowledge is <i>facing</i> the opportunistic behaviours of the other agents in the market. More precisely, the agents who may capture for free the new piece of knowledge are anonymous. The mechanisms of externalities generated by the producer of knowledge, on which the diffusion process relies, are "isotropic". As in a market mechanism, one can refer to a "representative agent", who benefits from the knowledge spillovers emitted by the producer of knowledge. 5. The producer of knowledge is not supposed to have emitting capacities. In other words, he has no the ability to "tune" the disclosure/secretcy dimension. He is just supposed to try and avoid the loss of the integrity of the piece of new produced knowledge. 6. All the agents of the economy have the full capability to absorb the innovative idea emitted by the producer of knowledge. Any buyer of the knowledge can effectively destroy the market, since he can reproduce the knowledge at very low cost. 7. The epistemic content of knowledge does not matter. The content of knowledge exhibits a "cognitive" equivalence, which means that in such a context it is impossible for instance to distinguish between the generic and specific forms of knowledge. 	<ol style="list-style-type: none"> 1. Knowledge is not a pure public good. It is a hybrid good that exhibits some properties of public good (the codified part of knowledge which is non-rival and non-exclusive) and some properties of private good (the tacit part which is at least partly exclusive). 2. Appropriation is not the only incentive for knowledge production. Firms do have others incentives than the direct exploitation of the monopoly rent: the willingness to maintain the firm on the technological frontier, the search for reputation, the objective of signalling, the need to build an absorptive capacity, and more generally the endeavours of agents in building competencies, etc. 3. The production of knowledge is not a solitary venture. It is generally produced within a community. The community could deliberately aim at producing new knowledge, as for the epistemic community (Cowan, David and Foray, 2000). However, the building of knowledge could also be made within other types of communities such as the communities of practice. Networking between academic institutions and private enterprises is a growing phenomenon that takes different forms. Networks can offer a way to share knowledge complementarities. It is also a way to build collective form of knowledge, and a sufficient level of trust between partners to facilitate the collective creation of knowledge. 4. The producer of knowledge is not facing the market, but a specific structure of interaction of economic agents. As Nonaka and Takeuchi (1995) mentioned, "organisational knowledge creation should be understood as a process that organisationally amplifies the knowledge created by individuals and crystallises it as a part of the knowledge network of the organisation. This process takes place within an "expanding community of interaction", which crosses intra and inter-organisational <i>levels and boundaries</i>". 5. The producer of knowledge has emitting capacities. An agent producing new knowledge will generally operate a selection between communities: on one side, he will consider to which communities the new knowledge is addressed, and on the other side those communities that he chooses to exclude. 6. The other agents have not full absorptive capabilities to absorb the innovative ideas emitted by the producer of knowledge. 7. The epistemic content of knowledge matters. There are forms of knowledge having a high degree of <i>generality</i> (knowledge which can be potentially used in various contexts by a large variety of agents), and very <i>specific</i> forms of knowledge that can be absorbed and used by few other agents.

